Infant Behavior & Development 34 (2011) 179–188

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Infant Behavior and Development

Dyadic and triadic skills in preterm and full term infants: A longitudinal study in the first year

Leentje De Schuymer[a,*], Isabel De Groote[a,b], Tricia Striano[c,d], Daniel Stahl[e], Herbert Roeyers[a]

[a] Department of Experimental Clinical and Health Psychology, Ghent University, Belgium
[b] University Centre of Child and Adolescent Psychiatry, Antwerp, Belgium
[c] Department of Psychology, Hunter College, New York, USA
[d] Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
[e] Department of Biostatistics, King's College, London, United Kingdom

ARTICLE INFO

Article history:
Received 3 June 2010
Received in revised form 3 December 2010
Accepted 3 December 2010

Keywords:
Prematurity
Social competence
Dyadic still-face
Gaze following
Infancy

ABSTRACT

This longitudinal study examined dyadic and triadic skills in 26 preterm and 31 full term infants at 3, 6 and 9 months of age. In dyadic interaction, infants engaged with a stranger in face-to-face play interrupted by a still-face episode. In triadic interaction, infants interacted with the adult stranger as she coordinated gaze between the infant and object. Both groups were sensitive for non-contingency in both dyadic and triadic interactions. There were significant group and developmental differences for dyadic and triadic competencies. Compared to full term infants, preterms made less positive elicits during the still-face at 6 months and followed gaze less at 9 months of age. Six-month dyadic skills and 9-month triadic competencies were positively related in preterm and full term infants.

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1. Introduction

The infant's social-communicative repertoire undergoes dramatic changes during the first year of postnatal development. Infants attend to social stimuli such as the human face and voice (Bahrick, Hernandez-Reif, & Flom, 2005; Rochat & Striano, 1999) and imitate facial expressions (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977) soon after birth. One of the most powerful paradigms to illustrate the early social relatedness and dyadic capacities of infants is the still-face procedure (Adamson & Frick, 2003). In the traditional paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978) a normal dyadic interaction is interrupted abruptly by the interacting adult, who adopts a still face and is thus behaving non-responsive. During this episode, infants show a dramatic decrease in smiling and gazing, and an increase in gaze aversion and negative affect. However, infants also make positive attempts to reengage the interaction partner (Adamson & Frick, 2003; Tronick et al., 1978), suggesting that they are active partners in dyadic interaction.

By the middle of the first year, triadic skills become more common as infants share attention to objects and activities with another person (Carpenter, Nagell, & Tomasello, 1998; Mundy, Sullivan, & Mastergeorge, 2009; Striano & Bertin, 2005a; Striano, Stahl, & Cleveland, 2009). As triadic skills such as gaze following are developing progressively (Moore, 2008), efforts have been made to investigate from what age on these can be observed. Scaife and Bruner (1975) were

* Corresponding author at: Ghent University, PP05, H. Dunantlaan 2, 9000 Ghent, Belgium. Tel.: +32 9 264 94 14, fax: +32 9 264 64 89.
E-mail address: Leentje.DeSchuymer@UGent.be (L. De Schuymer).

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doi:10.1016/j.infbeh.2010.12.007

the first to investigate gaze following at an age as young as 2 months. More recently, D'Entremont, Hains, and Muir (1997) found 3-month-old infants to follow gaze toward a target situated within the visual field of the infant. However, as the 3-month-olds only glanced at the target, the authors described it as a precursor of a joint attention mechanism. In line with this conclusion, Striano and Stahl (2005) investigated if normal developing infants from 3 months on showed a sensitivity for triadic attention. They designed a paradigm that was replicated in the present study. The behavior of 3-, 6-, and 9-month old infants was compared in 2 conditions: one normal gaze following condition (i.e., the joint attention condition) and one condition that missed a key feature of joint attention, namely the alternation and monitoring of the attention (i.e., the look away condition). The latter condition involved the adult looking for 1 min at the object. From 3 months on, infants showed reduced smiling and gazing during the look away condition in comparison to the joint attention condition, suggesting that 3-month-old infants are sensitive to a lack of attunement in a triadic context.

Social-communicative disturbances in preterm infants are well-documented (Crawford, 1982; De Groote, Roeyers, & Warreyn, 2006; Feldman, 2007). In a dyadic context, they are less alert, active, and responsive, they vocalize and play less, and they show more negative affect and gaze aversion than their full term counterparts (Eckerman, Hsu, Molitor, Leung, & Goldstein, 1999; Eckerman, Oehler, Medvin, & Hannan, 1994; Field, 1987; Malatesta, Grigryev, Lamb, Albin, & Culver, 1986; van Beek, Hopkins, & Hoeksma, 1994). The use of the still-face procedure in preterm children gave evidence that they are as sensitive as full term infants to detect a lack of attunement within a dyadic interaction, but show deficits in affect regulation (Hsu & Jeng, 2008; Segal, Oster, Cohen, Caspi, Myers, & Brown, 1995).

Sensitivity for triadic attention has not been investigated in preterm infants, but triadic skills can be affected by preterm birth. Twelve-month-old preterm infants respond less to joint attention bids as opposed to their full term counterparts (Olafsen et al., 2006). In addition, preterm infants avert their gaze more often during joint attention play, they show less shifts in their gaze, notice less objects, examine fewer toys, and show a persistence of these problems into the second year of life, irrespective of the medical risk (Landry & Chapieski, 1988; Landry, Schmidt, & Richardson, 1989; Landry, Smith, Miller-Loncar, & Swank, 1998).

Dyadic and triadic skills are important in early development related to subsequent development of language and communication (Cohn, Campbell, & Ross, 1991; Moore, Cohn, & Campbell, 2001; Mundy et al., 2007; Mundy & Gomes, 1998; Sheinkopf, Mundy, Claussen, & Willoughby, 2004). Only few studies have examined the developmental link between dyadic and triadic skills (Striano & Rochat, 1999; Yazbek & D'Entremont, 2006) in typically developing infants. In both studies, the dyadic skills were reflected by the level of re-engagement attempts made by the infants during a still-face episode. Triadic competence involved competencies such as joint engagement and attention following. Striano and Rochat (1999) showed that 7- and 10-month old infants who were more likely to reengage the interaction partner in a dyadic context were also more competent in a triadic context. Yazbek and D'Entremont (2006) found similar results, showing that dyadic re-engagement at 6 months predicted gaze following at 12 months.

It is unclear if deviances in dyadic skills impact later triadic skills in preterm children, who have successive risk for less favorable development in both the dyadic as triadic frame.

Therefore, the main objective of the study is to assess dyadic and triadic skills in preterm and full term infants and to investigate the developmental link between those skills.

The skills of preterm and full term infants were assessed at the age of 3, 6 and 9 months, with age corrected for prematurity. A modification of the traditional still-face paradigm (i.e., dyadic context) and a modification of the paradigm of Striano and Stahl (2005; i.e., triadic context) were used.

The first aim of the study is to investigate the sensitivity of preterm infants for non-contingencies within a dyadic and triadic context. It was expected that infants would show diminished gaze and smiling when the interaction suddenly missed dyadic responsiveness (i.e., still-face episode) or triadic alternating attention (i.e., look away episode). Congruent with previous research, it was expected that preterm infants would show the dyadic sensitivity in a similar way as full term infants. For triadic sensitivity, the same conclusion could count. This would give evidence that preterm birth does not interfere with the sensitivity to detect lack of attunement in an interaction. On the other hand, a lack of triadic sensitivity could be one possible process explaining triadic difficulties in preterm infants.

The second aim of the study is to investigate dyadic and triadic competence in preterm and full term infants from a developmental perspective. First, it was expected that preterm infants would make less positive dyadic attempts to re-engage the interaction partner in the still-face episode. As some studies report that group differences in dyadic competence diminish over time (Barnard, Bee, & Hammond, 1984; Crawford, 1982), this difference was expected to become less pronounced with growing age. Concerning triadic competence, it was expected that preterm infants would show gaze following to a lesser degree than full term infants. As researchers agree that joint attention can be seen in a robust way from the age of 9 months on, it was expected that the group difference would be most apparent at 9 months.

Finally, the developmental link between dyadic and triadic competence is investigated in preterm and full term infants. It was expected that more re-engagement attempts during the still-face episode at 3, 6 and 9 months would be positively correlated with gaze following at 9 months. Most interesting, we wondered if this correlation would exist in preterm infants and if it would be different from the correlation in full term infants.

Table 1
Medical characteristics of the preterm sample.

	Preterm ($n = 26$)		
	M	SD	Range
Birth weight (g)	1279.15	413.49	520–2200
Gestational age (weeks)	29.31	1.89	26–32
Apgar score 1 (min)	6.12	2.42	1–9
Apgar score 5 (min)	7.42	2.12	1–9
Time on respirator (days)	5.19	5.56	0–21
Time on oxygen (days)	23.42	31.06	0–100
Time in NICU (days)	56.73	30.01	16–107
	n	%	
Small for gestational age[a]	4	15	
Respiratory distress syndrome	15	58	
Grade III/IV	1	4	
Intraventricular hemorrhage	5	19	
Grade III/IV	2	8	

[a] Birth weight below 10% of the population mean for a given gestational age.

2. Method

2.1. Subjects

The sample consisted of 31 full term and 26 preterm infants. The preterm infants were recruited by a neonatal intensive care unit. Inclusion criteria were defined to limit the variation in the biological risk with which infants were born. At first, preterm infants were included in this study if they had a gestational age of 32 weeks or less at birth (i.e., very preterm born; e.g., Moreau et al., 2005). Table 1 shows the medical characteristics of the preterm sample. Second, infants were not invited to participate if they were diagnosed by the attending neonatologist with sensory impairments, meningitis, encephalitis, symptomatic congenital syphilis, congenital abnormality of the brain, or short bowel syndrome. They were also not invited if the primary caregiver was younger than 18 years of age, abused drugs, or was non-Dutch speaking. Of all preterm infants who met the inclusion criteria, six preterm infants and their parents (19%) did not wish to participate for a variety of reasons.

The full term group consisted of infants who were born after a normal pregnancy history, between 38 and 42 weeks of gestation. Physical exam was normal at birth. The infants and their parents were recruited by local primary health services and hospitals. The mean socio-economic status score (SES; Hollingshead, 1975) based on educational and occupational level of both parents did not differ between groups. Most infants were living in middle to high SES families. The groups did not differ on gender ratio and birth order; however, there were more boys than girls in both groups (see Table 2). The parents gave their consent for participation and received a small gift and a videotape of the sessions.

2.2. Procedure

The longitudinal study included the data of the infants at 3, 6 and 9 months of age in a dyadic (DY) and triadic (TR) interaction. Infants were examined within 10 days before or after these ages. The age of the preterm infants was corrected for the amount of prematurity. The attrition rate was 0%, however, data of some infants were missing at 3 months (preterm:

Table 2
Demographic characteristics of the preterm and full term sample.

Variables	Preterm ($n = 26$)		Full term ($n = 31$)	
	n	%	*n*	%
Gender				
Male/female	19/7	73/27	22/9	71/29
Birth order				
First born/later born	16/9	65/35	19/12	61/39
Variables	Preterm ($n = 26$)		Full term ($n = 31$)	
	M	SD	*M*	SD
Socio-economic status	44.02	10.28	48.31	10.31
Age (days)				
Three months	93.92	6.52	91.10	6.87
Six months	185.54	5.73	181.58	4.39
Nine months	270.62	4.66	273.62	4.66

$n = 2$ (DY), $n = 3$ (TR); full term: $n = 9$ (DY), $n = 2$(TR)), at 6 months (preterm: $n = 4$ (DY), $n = 5$ (TR); full term: $n = 6$ (DY), $n = 1$ (TR)) and at 9 months (preterm: $n = 2$ (DY), $n = 2$ (TR); full term: $n = 5$ (DY)) due to technical failure, fussiness during the examination (i.e., continuously crying for more than 30 s), or illness during the time period of examination. The procedure was identical at all ages and took place in a child development laboratory room, covered with black curtains to prevent visual distraction. Three- and 6-month-old infants were seated in a commercial seat, placed on a table. Nine-month-old infants were seated in a highchair. Infants were not allowed to have a toy or pacifier during the experiment. The infant and a female experimenter were sitting face-to-face, on eyelevel, approximately one meter from one another. Two cameras on the ceiling recorded the experiment and were mixed into a split-screen. One camera made a close-up of the child. The other camera recorded the infant as well as the experimenter from the side, mainly focused on the face of the infant. Infants were placed in the seat by the caregiver when he or she judged that the infant was alert and quiet. The caregiver then left the room and followed the experiment through a monitor. The examination consisted for all children of a triadic interaction followed by a dyadic interaction. Between the triadic and dyadic interaction the caregiver came back into the laboratory room and interacted with the infant for about 5 min, until he or she judged that the infant was alert and relaxed.

2.2.1. Triadic interaction

Two black stands, one to the right and one to left of the infant, were placed approximately 75 cm and 35° away from the infant's midline. A toy of 12 cm was placed on each stand. These two toys were bright-colored plastic ducks and were chosen because they were age-appropriate and because it could be assumed that infants had similar toys at home. The same female experimenter (E1) examined all children. During the triadic interaction, she only focused attention on one of the two toys (the target). Another experimenter (E2) timed the experimenter, out of view of the child and visually cued E1 when to start and stop each condition. Infants interacted with E1 for 5 min. E1 did not touch the infants during the experiment. Minutes 1, 3 and 5 consisted of normal, dyadic interactions between the infant and E1. E1 tried to create a playful interaction, by singing, smiling, imitating and/or talking to the infant. Minutes 2 and 4 consisted of a *Joint Attention* or a *Look Away* episode. In the Joint Attention condition, E1 alternated her attention between one of the objects and the infant. She looked away from the infants to look at the object for about 5 s, smiled and said phrases such as 'What a nice thing' or 'The thing is yellow and red' with a quiet but positive tone of voice. E1 turned back to the infant, established eye contact for about 5 s while talking and smiling. She repeated the same procedure for one minute. In the Look Away condition, E1 looked for the whole 1 min at the target object, without alternating attention between the object and the infant. She continued to talk and smile at the object. The same types of phrases as in the Joint Attention condition were used. The Joint Attention and Look Away condition only differed in a way that E1 did not alternate her attention between the target object and the infant in the Look Away condition. The order of the conditions was counterbalanced across infants.

2.2.2. Dyadic interaction

The experimenter (E2) who had visually cued E1 during the triadic interaction, interacted with the children, without touching him or her. E1 timed the interaction, out of view of the child, and visually cued E2 when to start and stop each condition. A modified still-face procedure was carried out, based on Striano and Rochat (1999). The procedure lasted 3 min and consisted of three episodes of 1 min each. In the first episode, E2 interacted with the child in a playful way, by singing, vocalizing, smiling, and imitating the infant. After this first episode, E2 suddenly adopted a still face for 1 min. She became silent, displayed a neutral, static, unresponsive face while keeping eye contact with the infant. In the third episode, E2 resumed the normal interaction with the infant.

When the infant cried continuously for longer than 30 s, the procedure was discontinued and the results were excluded from the analyses.

2.3. Coding and reliability

2.3.1. Triadic interaction

Infant measures were duration of (1) gazing toward the experimenter: looking at the face of E1, (2) gazing toward the target object, (3) gazing toward the non-target object, (4) gazing away: looking away from the objects and the experimenter (e.g., looking at the ceiling, own feet or in the direction of the target object but not exactly), and (5) smiling: cheeks raised and lips turned upward, with or without mouth opening, while gazing.

2.3.2. Dyadic interaction

Infant measures were duration of (1) gazing toward the experimenter: looking at the face of E2 and (2) smiling: cheeks raised and lips turned upward, with or without mouth opening, while gazing. Based on previous research (Striano & Rochat, 1999), attempts of the infants to reengage the experimenter were also coded. Only attempts that were clearly directed to the experimenter, namely attempts accompanied by gazing toward the experimenter, were taken into account: duration of (3) positive vocalizing: vocalization while gazing toward the experimenter, and (4) motor re-engagement actions: clapping, waving, banging, reaching toward the experimenter while gazing toward the experimenter.

The Observer (Noldus) was used to analyze all tapes. Coding of all behaviors was performed at half-speed. If necessary, coders stopped the tapes and reviewed the behaviors at lower speed or in real time. Two independent coders who were blind

Table 3
Percentages duration of time in normal interaction NI1, still-face SF and NI2, averaged over groups and ages.

Variables	NI1		SF		NI2	
	M	SD	*M*	SD	*M*	SD
Gazing at E	76.03	20.39	43.78	22.62	74.01	22.88
Smiling	25.14	23.23	8.76	11.56	22.94	22.70
Vocalizations	3.21	4.95	6.50	10.52	4.13	8.96
Motor actions	2.22	3.98	3.56	5.67	1.80	4.09

to the hypotheses and status of the children analyzed all tapes. Twenty percent randomly selected tapes were double coded. A tolerance window of 1 s was accepted. Cohen's Kappa was .87 or higher for all variables at all ages and across groups.

2.4. Statistical analyses

Different statistical analyses were performed and specific main and interaction effects were of interest. For clarity, an overview follows.

Concerning statistical analyses, multilevel (hierarchical) linear modeling (MLM) was used to investigate (1) the *sensitivity for dyadic and triadic contingency* and (2) *dyadic and triadic competence*. Pearson correlations were performed to examine (3) the *developmental link* between dyadic and triadic competence.

Concerning (1) and (2) different main and interaction effects were of interest. To assess *sensitivity for dyadic and triadic contingency* and the group and age differences of this sensitivity, the episode main effect (dyadic interaction versus still-face; joint attention versus look away) and the group × episode interaction and age × episode interaction were of interest. To assess *dyadic and triadic competence* in the two groups and at the three ages in combination with the developmental differences between the groups, the age and group main effects and the age × group interaction effect were of interest.

3. Results

For research question (1) and (2) MLM using SPSS 15.0 (Linear Mixed Models) was used to analyze the repeated-measures design. In this type of analyses, there is no requirement for complete data over occasions, and it has the flexibility to model the dependency of the repeated observations (Tabachnick & Fidell, 2007). Percentage duration of time that infants engaged in a specific behavior was used as the dependent variable. Following significant effects, pairwise Bonferroni comparisons were performed.

3.1. Sensitivity for dyadic contingency

Episode (normal interaction NI1, still-face SF, NI2), group (preterm versus full term) and age (3, 6 and 9 months) were entered as independent factors. Preliminary analyses yielded no significant effect of gender, so this variable was collapsed in subsequent analyses. As in all the subsequent models, the main effects and the two-way interaction effects of the independent factors were included into the model, but only the effects that were related to a specific research question were discussed. Three-way interaction effects were not added to the model, as preliminary analyses yielded that these interaction effects were not significant. To answer questions concerning group and developmental differences of the still-face effect, the main effect of episode and its interaction with group and age were of interest.

The analyses yielded significant episode main effects for gazing at E, $F(2, 362) = 132.60$, $p < .01$, for smiling, $F(2, 362) = 39.77$, $p < .01$, for vocalizations, $F(2, 362) = 6.61$, $p < .01$, and for motor actions, $F(2, 362) = 6.82$, $p < .01$. A significant episode × age interaction was found for gazing at E, $F(4, 362) = 5.73$, $p < .01$. No episode × age interaction was found for smiling, positive vocalizing and motor re-engagement actions.

Infants gazed less toward the experimenter, smiled less, showed more positive vocalizations, and manifested more motor re-engagement actions during the still-face episode in comparison to both normal dyadic interaction episodes. In addition, the decrease in gazing from NI1 to SF and the increase in gazing from SF to NI2 became more pronounced with growing age. For all measures, there was no difference between the two dyadic interaction episodes. Descriptive statistics of the overall differences between the 3 episodes can be found in Table 3. No interaction effects are taking into account to be succinct.

No significant episode × group interaction was found, indicating that the still-face effect did not differ between preterm and full term infants.

3.2. Sensitivity for triadic contingency

Episode (Joint Attention JA, Look Away LA), group (preterm versus full term) and age (3, 6 and 9 months) were entered as independent factors. Preliminary analyses yielded no significant effect of gender or order (LA–JA or JA–LA) so these variables were collapsed in subsequent analyses. Following Flom and Pick (2005) reliable gaze following was computed by subtracting the percentage duration of gazing at the non-target object from the percentage duration of gazing at the target

Table 4
Percentages duration of time in joint attention (JA) and look away (LA) episode, averaged over groups and ages.

Variables	JA		LA	
	M	SD	*M*	SD
Gazing at E	65.01	23.67	52.80	23.99
Smiling	11.20	13.84	4.15	9.57
Gazing away	13.28	17.72	22.85	21.33
Gaze following[a]	8.42	14.51	9.08	16.44

[a] Gaze following is the percentage duration of gazing at the target minus gazing at the non-target.

object. The episode main effects and its interaction with group and age were of interest. The analyses yielded significant episode main effects for gazing at E, $F(1, 258) = 27.31$, $p < .01$, for smiling, $F(1, 258) = 33.38$, $p < .01$, for gazing away, $F(1, 258) = 27.92$, $p < .01$, but not for reliable gaze following. In addition, a significant age × episode interaction was found for gazing away, $F(2, 258) = 3.63$, $p < .05$, and a marginally significant age × episode interaction was found for gazing at E, $F(2, 258) = 2.67$, $p < .1$. For reliable gaze following and smiling, no age × episode interaction was found.

Thus, infants followed gaze to a similar amount in LA as in JA but they gazed less long at E, smiled less, and gazed away more during LA than during JA. Furthermore, the difference between JA and LA in gazing away and gazing at E seemed more pronounced at 3 months than at 6 and 9 months. Descriptive statistics of the overall differences between the 2 episodes can be found in Table 4. No interaction effects are taking into account to be succinct.

No group × episode interactions were found, indicating that the behavioral differences between JA and LA were similar in the preterm and full term group.

3.3. Dyadic competence

Dyadic re-engagement behaviors during the still-face episode were assessed. Given that (1) the absolute time the infants gazed toward E diminished with growing age (i.e., main effect of age, $F(2, 137) = 6.64$, $p < .01$), and (2) smiling, vocalizing and motor actions were only coded when the infants gazed at E, the percentages duration of smiling, vocalizing and motor actions were divided by the percentage duration of gazing to E for each infant at each age. Analyses with these 'new' variables would indicate how often an infant would combine gazing with re-engagement behaviors independent on his or her absolute amount of gazing. Age (3, 6 and 9 months) and group (preterm and full term) were entered as independent factors.

3.3.1. Smiling while gazing during SF

An age main effect, $F(2, 137) = 8.29$, $p < .001$, and an age × group interaction was found, $F(2, 137) = 3.47$, $p < .05$. There was no group main effect. Preterm and full term infants showed another pattern of change over time (see Fig. 1). The full term infants showed a curvilinear pattern: a significant increase in smiling while gazing from 3 to 6 months, and a non-significant decrease from 6 to 9 months. The preterm infants followed a linear pattern with an increase in smiling while gazing with growing age, and with the highest increase from 6 to 9 months. As a result, preterm and full term infants did not differ in amount of smiling at 3 months and 9 months, but differed at 6 months, with full term infants smiling significantly more than preterm infants.

3.3.2. Positive vocalizing while gazing during SF

There was an age main effect, $F(2, 136) = 7.42$, $p < .01$, and a group main effect, $F(1, 136) = 5.40$, $p < .05$. In addition, an age × group interaction was found, $F(2, 136) = 3.99$, $p < .05$. Infants showed increasingly more positive vocalizing while gazing at 6 months in comparison to 3 and 9 months, but this was only true for the full term infants. The percentage duration of positive vocalizing did not augment significantly for preterm infants at any age (see Fig. 2).

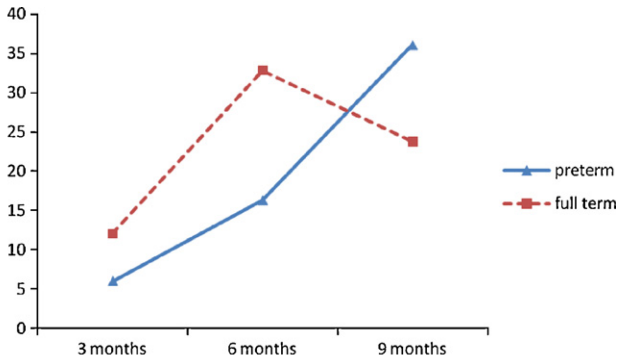

Fig. 1. Percentage smiling while gazing as a function of age and group.

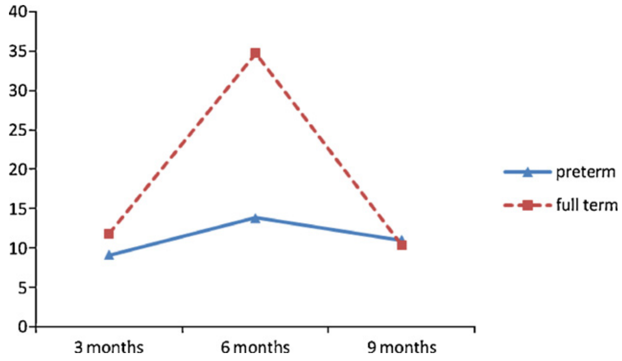

Fig. 2. Percentage vocalizing while gazing as a function of age and group.

3.3.3. Motor re-engagement actions while gazing during SF

There was an age main effect, $F(2, 136) = 12.01$, $p < .01$, such that infants showed more motor re-engagement actions in the period they gazed toward E at 6 and 9 months as compared to at the age of 3 months. There was no group main effect and no age × group interaction effect.

3.4. Triadic competence

Episode (Joint Attention JA, Look Away LA), group (preterm versus full term) and age (3, 6 and 9 months) were entered as independent factors. The main effects of group and age and the interaction between these two factors were of interest. Reliable gaze following was the dependent variable.

An age main effect was found, $F(2, 263) = 11.76$, $p < .01$, such that infants followed gaze to a lesser degree at the age of 3 months in comparison to at the ages of 6 and 9 months. No group main effect was found. There was a significant group × age interaction, $F(2, 263) = 4.02$, $p < .05$ (see Fig. 3). Preterm infants followed gaze to a lesser degree than full term infants at the age of 9 months. The groups did not differ significantly at the age of 3 and 6 months.

A one-sample *t*-test was performed to analyze whether infants of all ages reliably gazed longer at the target object by testing the difference score against chance value 0. Both preterm as full term infants reliably followed gaze from 3 months on ($p < .05$ for all ages and for both groups).

3.5. Link between dyadic and triadic competencies

Two different methods were used. First, analyses were performed on the *duration* of re-engagement attempts during the still-face episode at 3, 6 and 9 months and the duration of reliable gaze following (i.e., the difference score) at 9 months. To lessen the number of variables of dyadic competence, composites were formed at each age with the *z*-scores of the duration of the several re-engagement attempts (smiling, vocalizing, motor activity). Pearson correlations were computed, but yielded no significant correlation between the duration of reliable gaze following at 9 months and the duration of re-engagement attempts at 3 months, $r(45) = .05$, *ns*, 6 months, $r(45) = -.08$, *ns*, or 9 months, $r(49) = -.01$, *ns*. The correlational data were also examined for the preterm and full term group separately, to examine if another correlational pattern could be found in the preterm group as compared to the full term group. However, this was not the case, as no significant correlational differences were found between the preterm and full term group by using Fisher's r to z transformation procedure.

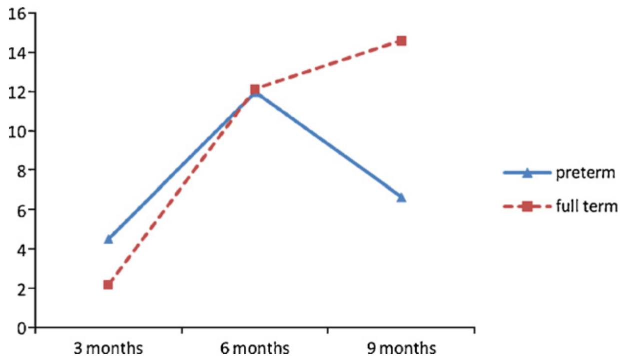

Fig. 3. Percentage reliable gaze following as a function of age and group.

Second, based on Striano and Rochat (1999) infants were assigned a certain *level* of dyadic and triadic competence. For the dyadic interaction, infants could receive a score from 0 to 3 based on their re-engagement behaviors (smiling, vocalizing, moving) during the still-face interaction. As the amount of smiling decreased from NI1 to SF, infants received a point if they smiled minimum once at E. As the amount of positive vocalizations and motor re-engagement actions increased from NI1 to SF, infants could receive points if they manifested an increase in positive vocalizations (1 point) and/or motor re-engagement actions (1 point). A score of 0–1 was considered as a low level of dyadic competence, whereas a score of 2–3 was considered as a high level. For the triadic interaction, infants could receive score 0 or score 1, based on the absence or presence of reliable gaze following during the joint attention episode. Infants were considered as a reliable gaze follower (i.e., score 1) if the difference score between gazing toward the target minus gazing toward the non-target was positive (>0).

To investigate the relationship between dyadic and triadic competencies, a Pearson correlation between the dyadic scores at 3, 6 and 9 months on the one side and triadic score at 9 months on the other side was computed. The analyses yielded no significant correlation between dyadic competence at 3 and 9 months and triadic competence at 9 months. However, a significant positive correlation was found between dyadic competence at 6 months and triadic competence at 9 months, $r(45) = .45$, $p < .01$. The correlations between 6-month dyadic and 9-month triadic competence were examined separately for preterm infants, $r(23) = .52$, and full term infants, $r(22) = .33$, but the correlations in the two groups did not differ significantly from each other as was investigated with Fisher's r to z transformation test.

4. Discussion

The present study assessed the competencies of preterm and full term infants within a dyadic and triadic social context throughout the first year of postnatal development.

Preterm infants reacted on the lack of attunement in a dyadic and triadic interaction as full term infants did, suggesting their sensitivity for non-contingency in an interaction. The infants gazed and smiled less toward the adult and averted their gaze more often when the interaction partner became non-responsive (dyadic still-face; see also Hsu & Jeng, 2008; Segal et al., 1995) or when she showed no alternated attention (triadic look away). However, in both contexts, the infants stayed partially involved. Preterm and full term infants made attempts to re-establish the dyadic interaction via smiles, vocalizations and motor actions during the still-face episode. In the triadic interaction, both groups followed gaze in a similar amount during the triadic look away and the joint attention episode, although the adult did not show alternated attention in the former episode.

Developmental growth was seen for dyadic and triadic skills in both groups. With growing age, and especially between 3 and 6 months of age, infants became increasingly inclined to combine gazing with re-engagement behaviors (i.e., smiling, vocalizing, motor re-engagement actions) during the dyadic still-face episode and to follow gaze during the triadic interactions.

The pattern of developmental growth was different between groups, resulting in age-specific differences. Longitudinal studies have shown that differences between preterm and full term children are not static, but increase (Gerner, 1999) or decrease (Barnard et al., 1984; Crawford, 1982) based on the ages of assessment. In the current study, no group differences were found in dyadic and triadic functioning at 3 months, possibly due to the fact that dyadic initiatives and triadic responsiveness are no age-appropriate measures at that young age. At 6 months, preterm infants smiled and vocalized less during the still-face episode than full term infants, a difference that was not apparent anymore at 9 months. However, at that age, preterm infants followed gaze to a lesser degree than their full term counterparts. These age-dependent group differences follow the line of normal development, as in the first 6 months of postnatal development, social skills are developing within a dyadic context, whereas interest in triadic interactions increases in the second 6 months of life (Feldman, 2007). In this perspective, it fits that group differences in dyadic and triadic skills were most apparent at respectively 6 and 9 months.

The main objective of the study was to find out if the differences in dyadic skills between infants and groups would be related to triadic skills. Given the before mentioned results, this correlation was expected especially between 6-month dyadic and 9-month triadic skills.

Partial evidence was found. The level of 6-month dyadic skills was related to the level of 9-month triadic skills. This conclusion was not found based on the duration of the behavior of infants: how long the infants showed re-engagement attempts during the still-face at 6 months was not correlated with how long infants gazed at the target at 9 months. However, *if* infants made more efforts at 6 months during the still-face episode compared to their baseline dyadic functioning, they would gaze more at the target at 9 months than at the non-target. This is congruent with Striano and Rochat (1999) reporting a developmental link between level of dyadic and triadic functioning, and especially with Yazbek and D'Entremont (2006) who found a predictive value of 6-month dyadic level to gaze following at 12 months.

No predictive or concurrent value was found between dyadic level at 3 and 9 months and triadic level at 9 months. It occurs often in longitudinal studies that the predictive value of a variable is significant at one age, but not at another age (e.g., Morales et al., 2000; Mundy et al., 2007), and this suggest that the interindividual differences in dyadic level were less meaningful at 3 and 9 months to predict level of triadic competence at 9 months.

Little is known about the processes underlying the dyadic and triadic development. Striano and Rochat (1999) gave evidence that dyadic and triadic skills are not merely an expression of individual differences in maturation. They suggested that the developmental link between dyadic and triadic skills reflects the *social* cognitive development in infants and not the *general* cognitive development. New advances in research has provided a more differentiated view on the social cognitive development, chiefly on the development of triadic skills, and shows that initiating versus responding to triadic bids are differentially related to unique processes in addition to common processes (Mundy, Card, & Fox, 2000; Mundy, Sullivan, & Mastergeorge, 2009). In line with these new advances, Yazbek and D'Entremont (2006) made a differentiation between responding (i.e., gaze following) and initiating triadic interactions and reported that only the former was related to the assessment of dyadic skills (i.e., dyadic initiatives).

In contrast to the fast development of knowledge concerning triadic skills, the processes underlying dyadic skills are far less explored. An intriguing challenge lies ahead to explore the processes that are moderating the developmental link between dyadic and triadic skills. This could be of interest, especially for children born preterm, as preterm birth poses infants at risk for a less favorable dyadic and triadic development, which seems to be related to each other.

Some limitations must be acknowledged. First, the small sample size and the specific inclusion criteria for the preterm infants restrict the generalizability of the findings to the heterogeneous group of preterm infants. However, most results were in line with the expectations and in line with previous findings in full term and preterm infants. Second, a stranger interacted with the infants. Although it was make sure that the infants were at ease before starting the interactions, infants' interactive behavior can be different when interacting with a mother or a stranger (Porter, Jones, Evans, & Robinson, 2009; Striano & Bertin, 2005b), a difference that becomes more obvious with growing age (Bigelow, Power, Mcquaid, Ward, & Rochat, 2008). However, as mothers of preterm infants are described to be more stimulating (Goldberg & DiVitto, 2002) the decrease in amount of stimulation from the normal dyadic and triadic interaction to the dyadic still-face and triadic look away would be more pronounced for preterm than for full term infants. Thus, in order to standardize the interactions, an adult stranger was preferred.

This study provides evidence for age-related difficulties in dyadic and triadic skills in preterm infants, and shows that dyadic skills can impact triadic skills in infants born at risk.

Acknowledgments

The authors wish to thank the Neonatal Intensive Care Unit of Ghent University Hospital, Child & Family and Jan-Palfijn Hospital for the aid in the recruitment of the children, and are grateful to the families for their participation.

This research was supported by a research grant of the Special Research Fund of Ghent University.

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